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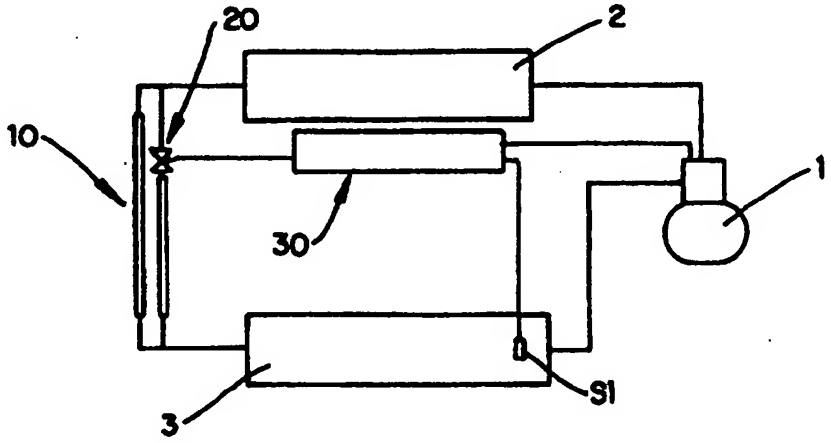
(54) Title: A REFRIGERATION SYSTEM FOR REFRIGERATION APPLIANCES

(57) Abstract

A refrigeration system for refrigeration appliances, comprising a condenser (2) connected between a compressor (1) and an evaporator (3) through a refrigerant fluid flow restricting means (10) comprising at least two parallel capillary tubes, each tube determining a certain restriction of the refrigerant fluid flow; a temperature sensor (S1), which is mounted in a region of the compartment to be refrigerated and which informs the temperature conditions in this region: a flow blocking means (20) in fluid communication with both the condenser (2) and the evaporator (3) through at least part of the capillary tubes (10), so as to selectively and temporarily allow the refrigerant fluid to pass through at least part of the capillary tubes (10) in series with the flow blocking means (20) when the temperature sensor (S1) detects the occurrence of a determined temperature condition; an electronic control unit (30), operatively connected with the flow blocking means (20), in order to command the opening of the latter when receiving from the temperature sensor (S1) the electric signal indicating the occurrence of said determined temperature condition.



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A REFRIGERATION SYSTEM FOR REFRIGERATION APPLIANCES

Field of the Invention

The present invention refers, in general, to a refrigeration system for refrigeration appliances and, more particularly, to refrigeration systems of refrigerators presenting at least two refrigerating functions, such as refrigerators which can also work as freezers.

Background of the Invention

One of the problems of most refrigerators and freezers refers to the quick temperature adaptation that their refrigeration system must present upon the introduction of a load with a temperature higher than the internal temperature of the refrigeration cabinet, or at each new start of the normal refrigerating operation. These problems are particularly enhanced when the refrigeration system works with a capillary tube as an expanding device.

The refrigeration appliances, specially the freezers working with a very restricted capillary tube, have a slow temperature reduction at start up or upon the introduction of a high thermal load inside the refrigeration cabinet. This slowness results from a refrigerant fluid flow through the capillary tube that is insufficient to fully cool the evaporator of the refrigeration system. Due to the high temperature of the air in the refrigeration compartment, the refrigerant evaporates very fast as soon as it reaches the evaporator, cooling only a small portion thereof adjacent to the inlet region of said evaporator and which receives the refrigerant fluid from the condenser.

A way to solve the problems above is to change the thermostat setting of the refrigeration appliance from an operational mode, in which said appliance works, for

example, as a refrigerator, to an operational mode in which it works as a freezer, in function of the refrigeration required by the load or by the internal temperature condition of the refrigeration cabinet. The change of the thermostat setting will stop the compressor in different limit temperatures of each normal operation temperature interval associated to each operational mode of said refrigeration appliance. When operating in the refrigerating mode, the compressor will stop before the negative temperature is reached inside the compartment to be refrigerated. Nevertheless, this solution of changing the thermostat setting only modifies the operational time of the compressor and does not modify the cooling capacity of the refrigeration appliance.

Disclosure of the Invention

Thus, it is an object of the present invention to provide a refrigeration system for a refrigeration appliance which permits to vary the refrigerant fluid flow supplied to the evaporator, in order to vary the cooling capacity of the system according to the temperature of the evaporator.

This and other objectives are attained by a refrigeration system for refrigeration appliances, comprising a compressor; a condenser connected between the compressor and an evaporator through a refrigerant fluid flow restricting means, comprising at least two parallel capillary tubes, each tube determining a certain restriction of the refrigerant fluid flow, said system further comprising a temperature sensor, mounted in a region of the compartment to be refrigerated, so as to produce electric signals indicating the temperature in this region; a flow blocking means in fluid communication with both the condenser and the evaporator through at least part of the capillary tubes, so as to selectively and temporarily allow the

refrigerant fluid to pass through at least part of the capillary tubes in series with the flow blocking means when the temperature sensor detects the occurrence of a determined temperature condition, at the region of the compartment to be refrigerated, outside the normal operation temperature interval; an electronic control unit, operatively connected with the flow blocking means, in order to command the opening of the latter when receiving from the temperature sensor the electric signal indicating the occurrence of the determined temperature condition at said region of the compartment to be refrigerated.

Brief Description of the Drawings

The invention will be described below, with reference to the attached drawings, in which:

Fig. 1 shows, schematically, a refrigeration system for refrigeration appliances of the present invention;

Fig. 2 shows, schematically in a block diagram, an electronic arrangement for the refrigeration system of the present invention; and

Fig. 3 shows, schematically, an embodiment of the electronic circuit for the control unit of the refrigeration system of the present invention.

Best Mode for Carrying Out the Invention

According to the illustrations, the refrigeration system of the present invention is applied to refrigeration appliances, comprising a hermetic compressor 1 having its high pressure side in fluid communication with the inlet of a condenser 2, so as to supply the latter with high pressure refrigerant gas, and having its low pressure side in fluid communication with the outlet of an evaporator 3, wherefrom it receives refrigerant gas under low pressure. The communication between the condenser 2 and evaporator 3 is made through a capillary tube 4 that permits the constant fluid communication of liquid refrigerant

fluid between the outlet of the condenser 2 and the inlet of the evaporator 3, during the operation of the compressor 1. This construction has the disadvantage of limiting the cooling capacity of said refrigeration system, as discussed above, when said system is required to work under anomalous temperature conditions, i.e., when the temperature of the evaporator is beyond, above or below the limits of a normal operation temperature interval of the refrigeration system. Such anomalous conditions occurs, for example, upon the introduction of high temperature loads inside a compartment to be refrigerated, particularly in refrigeration cabinets of the refrigeration appliance, upon the start up of the refrigerating operation of said refrigeration compartment.

The present invention modifies the cooling capacity of a refrigeration system, by varying, in a controlled way, the restriction of the refrigerant fluid flow between the condenser 2 and evaporator 3, said restriction variation being determined in function of the temperature measured at a region of the compartment to be refrigerated, particularly in a median portion of the evaporator 3, preferably adjacent to the refrigerant gas outlet, wherefrom said gas is conducted under low pressure to the compressor 1.

According to the present invention, the fluid flow restriction is obtained, by providing the refrigeration system described above with a refrigerant fluid flow restricting means 10, comprising two parallel capillary tubes, each determining a certain flow restriction of the refrigerant fluid. One of said capillary tubes, such as the capillary tube normally used in the art, is maintained in constant fluid communication with the condenser 2 and evaporator 3, whereas the other of said capillary tubes is mounted in series with a fluid

blocking means 20, preferably a blocking valve of the solenoid type which, when energized, permits selectively and temporarily the fluid communication between the condenser 2 and evaporator 3 through the capillary tube with which it is disposed in series.

According to a preferred illustrated form of the present invention, the capillary tube maintaining constant fluid communication between the condenser 2 and evaporator 3 has a refrigerant fluid flow adequate for the normal operation of the refrigeration system, whereas the capillary tube in series with the blocking valve 20 allows for a higher flow of refrigerant fluid when in operation, thereby increasing the cooling capacity of the system when the blocking valve 20 is open.

The opening and closing of the blocking valve 20 is determined by an electronic control unit 30, which is operatively connected with said valve, in function of determined electronic signals received from a temperature sensor S1 mounted at the outlet region of the evaporator 3 and which monitors the temperature thereof, producing electric signals which indicate the temperature at the region where it is mounted and which are sent to the control unit 30.

The opening of the blocking valve 20 occurs when the electric signals sent by the temperature sensor S1 indicate the occurrence of a determined temperature condition in the region where said sensor S1 is mounted, outside a normal operation temperature interval in this region.

The commanding operations for opening and closing the blocking valve 20 by the control unit 30 are achieved through a flow blocking thermostat T of said valve connected to both the temperature sensor S1 and blocking valve 20.

When load is introduced into the cabinet to be

refrigerated, the temperature sensor S1 detects a determined temperature outside the normal operation temperature interval and which, besides causing the operation of the compressor, activating the refrigeration system, makes the control unit 30 open the blocking valve 20, increasing the cooling capacity of the system by increasing the flow of refrigerant fluid to the evaporator 3. Thus, the heat exchange between the refrigerant fluid coming into the evaporator 3 and the air of the compartment to be refrigerated will occur practically throughout the whole heat exchange area of said evaporator 3. In the prior art, due to the small flow of refrigerant fluid when in a same temperature condition, said heat exchange occurred only in a small area of the evaporator 3 adjacent to the inlet thereof, thereby only cooling efficiently the portion of said compartment adjacent to the inlet of the evaporator 3.

When the temperature sensor S1 informs the control unit 30 that the temperature in the evaporator 30 is already within the normal operation temperature interval of the system, said control unit 30 commands the closing of the blocking valve 20 through the flow blocking thermostat T, forcing the refrigerant fluid coming from the condenser 2 to reach the evaporator 3 through the capillary tube having a normal refrigerant fluid flow.

Though not illustrated, the variation of the cooling capacity of the refrigeration appliance of the present invention may be further gradually modified, this controlled variation being obtained by providing the refrigeration system with a refrigerant fluid flow restricting means, including a plurality of capillary tubes parallel to each other, at least part of said capillary tubes being in series with a respective fluid blocking means which will liberate the passage of refrigerant fluid through the corresponding tubes in

series, in function of the temperature in the evaporator 3 and when the temperature sensor S1 detects in the evaporator 3 the occurrence of a determined anomalous temperature condition.

With this construction, the temperatures situated above or below the normal operation temperature interval of the refrigeration appliance will activate the opening of one or more capillary tubes, so as to allow for a larger or smaller flow of refrigerant fluid to the evaporator 3, respectively. A variant of this construction presents all of the capillary tubes in series with a respective fluid blocking means. In either construction, the refrigerant fluid flow restricting means may include a plurality of capillary tubes, equal to each other and each presenting a determined flow, so as to allow combinations therebetween, defined in function of the refrigeration required by the refrigeration appliance.

According to the illustrations of figures 2 and 3, the refrigeration system of the present invention is applied to refrigeration appliances having a double operational mode: as a refrigerator and as a freezer, each operational mode having a respective normal operation temperature interval, which is previously known by the control unit 30 and which is automatically activated upon determining which operational mode will be used by the refrigeration appliance.

In the present construction, the operational modes of the refrigeration appliance are alternatively and selectively determined by a selecting switch CH1, preferably a selecting switch CH1 operatively connected to both the control unit 30 and to first and second thermostats T1, T2, each of said thermostats being associated with a respective operational mode of the refrigeration appliance. Said thermostats are selectively, individually and operatively connected to

both the temperature sensor S1 and compressor 1, in order to cause the change in the energizing condition of said compressor 1, when the temperature sensor S1 detects a temperature in the evaporator 3 equal to one of the limit temperatures of the respective normal operation temperature interval of the refrigeration appliance.

The selecting switch CH1 connects selectively and automatically the compressor 1 with the temperature sensor S1 through one of the first or second thermostats T1, T2, upon the selection of each respective operational mode of the refrigeration appliance.

According to a preferred form illustrated in figure 3, the control unit 30 has an electronic circuit 40, which is supplied with energy from a power source F and which comprises a temperature monitoring circuit 41 formed by a first resistor R1 and a temperature sensor S1; a blocking thermostat circuit 42, operatively connected to the flow blocking thermostat T, in order to allow the energization and deenergization of the blocking valve 20; a first operational mode thermostat circuit 43 and a second operational mode thermostat circuit 44.

The blocking thermostat circuit 42 includes second, third and fourth resistors R2, R3 and R4, respectively, a terminal of the second resistor R2 being connected to the power source F, whereas the other terminal is connected to a terminal of the third resistor R3 and to an inlet positive pole of a first operational amplifier AO1 of said blocking thermostat circuit 42, whose inlet negative pole is connected to the selecting switch CH1. The outlet terminal of the first operational amplifier AO1 is connected to a connection, that is common to the other terminal of the third resistor R3 and to one of the terminals of the fourth resistor R4. The thermostat

blocking circuit 42 further comprises a first transistor Q1 and a first relay RL1 which, when energized, operates the variation of condition of a first contact switch V1 of the blocking valve 20, so as to conduct the latter to its opening condition, to allow the refrigerant fluid to pass to the capillary tubes 10 in series with said blocking valve 20.

The first operational mode thermostat circuit 43 comprises a fifth resistor R5, connected to the power source F and to the inlet positive pole of a second operational amplifier AO2 of said first operational mode thermostat circuit 43, said operational amplifier having its inlet negative pole in contact with the selecting switch CH1 and its outlet terminal connected to a first common connecting region, to which is connected a terminal of a sixth resistor R6, that is also connected by its other terminal to a median portion between the fifth resistor F5 and the positive pole of the second amplifier AO2. To the first common connecting region is connected a terminal of a seventh resistor R7, whose opposite terminal is connected to a second transistor Q2 and to a second relay RL2 operatively connected to a start contact switch of the compressor 1.

The second operational mode thermostat circuit 44 comprises, in a construction similar to the above described circuit, an eigth resistor R8 connected to the power source F and to the inlet positive pole of a third operational amplifier AO3 of said second operational mode thermostat circuit 44, said operational amplifier having its inlet negative pole in contact with the selecting switch and its outlet terminal connected to a second common connecting region, whereto is connected a terminal of a ninth resistor R9, that is also connected by its other terminal to a median portion between the eigth resistor

R8 and the positive pole of the third amplifier AO3. To the second common connecting region is connected a terminal of a seventh resistor R7, which is also connected to the terminal of the sixth resistor R6 of the first operational mode thermostat circuit 43.

CLAIMS

1. A refrigeration system for refrigeration appliances, comprising a compressor (1); a condenser (2) connected between the compressor and an evaporator (3) through a refrigerant fluid flow restricting means (10), characterized in that the restricting means (10) comprises at least two parallel capillary tubes, each tube determining a certain restriction of the refrigerant fluid flow, said system further comprising a temperature sensor (S1), mounted in a region of the compartment to be refrigerated, so as to produce electric signals indicating the temperature in this region; a flow blocking means (20) in fluid communication with both the condenser (2) and the evaporator (3) through at least part of the capillary tubes (10), so as to selectively and temporarily allow the refrigerant fluid to pass through at least part of the capillary tubes (10) in series with the flow blocking means (20) when the temperature sensor (S1) detects the occurrence of a determined temperature condition, at the region of the compartment to be refrigerated, outside the normal operation temperature interval; an electronic control unit (30), operatively connected with the flow blocking means (20), in order to command the opening of the latter when receiving from the temperature sensor (S1) the electric signal indicating the occurrence of the determined temperature condition at said region of the compartment to be refrigerated.

2. System, as in claim 1, characterized in that the temperature sensor S1 is mounted in an outlet region of the evaporator (3).

3. System, as in claim 1, characterized in that the refrigerant fluid flow restricting means (10) has at least one capillary tube, which is disposed parallely

AMENDED CLAIMS

[received by the International Bureau on 13 June 1996 (13.06.96); original claims 2-8 cancelled; original claim 1 amended; original claims 9 and 10 amended and renumbered as claims 2 and 3 (4 pages)]

1. A refrigeration system for refrigeration appliances, comprising a compressor (1); a condenser (2) connected between the compressor and an evaporator (3) through a refrigerant fluid flow restricting means (10), characterized in that the restricting means (10) comprises at least two parallel capillary tubes, each tube determining a certain restriction of the refrigerant fluid flow, said system further comprising a temperature sensor (S1), mounted in a region of the compartment to be refrigerated, so as to produce electric signals indicating the temperature in this region; a flow blocking means (20) in fluid communication with both the condenser (2) and the evaporator (3) through at least part of the capillary tubes (10), so as to selectively and temporarily allow the refrigerant fluid to pass through at least part of the capillary tubes (10) in series with the flow blocking means (20) when the temperature sensor (S1) detects the occurrence of a determined temperature condition, at the region of the compartment to be refrigerated, outside the normal operation temperature interval; an electronic control unit (30), operatively connected with the flow blocking means (20), in order to command the opening of the latter when receiving from the temperature sensor (S1) the electric signal indicating the occurrence of the determined temperature condition at said region of the compartment to be refrigerated, said electronic control unit (30) comprising first and second operational mode thermostats (T1, T2), each operational mode corresponding to a respective normal operation temperature interval in a region of the compartment to be refrigerated and which are selectively, individually and operatively connected to both the temperature sensor (S1) and compressor (1), in order to cause a change in the energizing condition of the compressor (1) when they receive from the temperature

sensor (S1) an electric signal indicating a limit temperature of the respective normal operation temperature interval associated to each thermostat; a selecting switch (CH1), selectively connecting the compressor (1) to the temperature sensor (S1) through one of the first or second thermostats (T1, T2), upon the selection of each respective operational mode of the refrigeration appliance.

2. System, as in claim 1, characterized in that the selecting switch (CH1) is manually conducted to each one of the operational modes.

3. System, as in claim 2, characterized in that the control unit (30) comprises an electronic circuit (40), which is supplied with energy from a power source (F) and which includes a temperature monitoring circuit (41) having a first resistor (R1) and the first temperature sensor (S1); a blocking thermostat circuit (42) operatively connected to the first temperature sensor (S1) and to a contact switch (V1) of the blocking valve, so as to allow the energization and deenergization of said valve; a first operational mode thermostat circuit (43) and a second operational mode thermostat circuit (44), the blocking thermostat circuit (42) including a plurality of resistors (R2, R3, R4); a first operational amplifier (AO1); a first transistor (Q1) and a first relay (RL1) operatively connected to the first contact switch (V1) of the blocking valve (20), the first operational mode thermostat circuit (43) comprising a pair of resistors (R5, R6); a second operational amplifier (AO2); a second transistor (Q2) and a second relay (RL2) operatively connected to a start contact switch of the compressor 1, the second operational mode thermostat circuit (44) comprising a pair of resistors (R8, R9) and a third operational amplifier (AO3).

corresponding to a respective normal operation temperature interval in a region of the compartment to be refrigerated, said system being characterized in that the control unit (30) comprises first and second operational mode thermostats (T1, T2), which are selectively, individually and operatively connected to both the temperature sensor (S1) and compressor (1), in order to cause a change in the energizing condition of the compressor (1) when they receive from the temperature sensor (S1) an electric signal indicating a limit temperature of the respective normal operation temperature interval associated to each thermostat; a selecting switch (CH1), selectively connecting the compressor (1) to the temperature sensor (S1) through one of the first or second thermostats (T1, T2), upon the selection of each respective operational mode of the refrigeration appliance.]

2[9]. System, as in claim 1[8], characterized in that the selecting switch (CH1) is manually conducted to each one of the operational modes.

3[10]. System, as in claim 2[8], characterized in that the control unit (30) comprises an electronic circuit (40), which is supplied with energy from a power source (F) and which includes a temperature monitoring circuit (41) having a first resistor (R1) and the first temperature sensor (S1); a blocking thermostat circuit (42) operatively connected to the first temperature sensor (S1) and to a contact switch (V1) of the blocking valve, so as to allow the energization and deenergization of said valve; a first operational mode thermostat circuit (43) and a second operational mode thermostat circuit (44), the blocking thermostat circuit (42) including a plurality of resistors (R2, R3, R4); a first operational amplifier (AO1); a first transistor (Q1) and a first relay (RL1) operatively connected to the first contact switch (V1) of the blocking valve (20), the first

operational mode thermostat circuit (43) comprising a pair of resistors (R5, R6); a second operational amplifier (AO2); a second transistor (Q2) and a second relay (RL2) operatively connected to a start contact switch of the compressor 1, the second operational mode thermostat circuit (44) comprising a pair of resistors (R8, R9) and a third operational amplifier (AO3).

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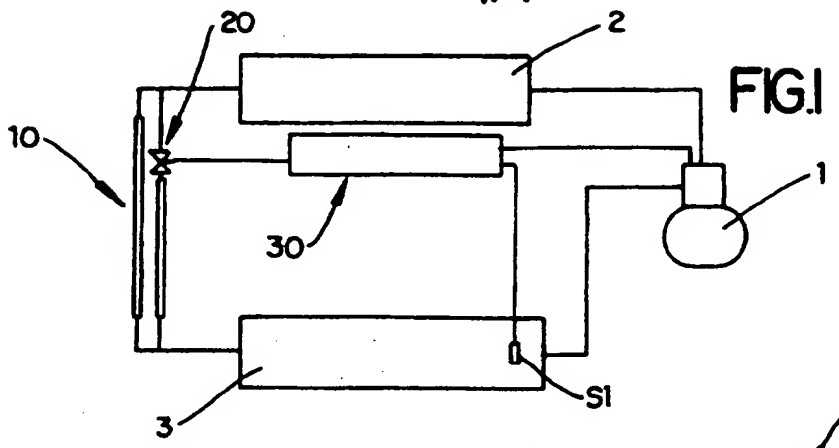

FIG.1

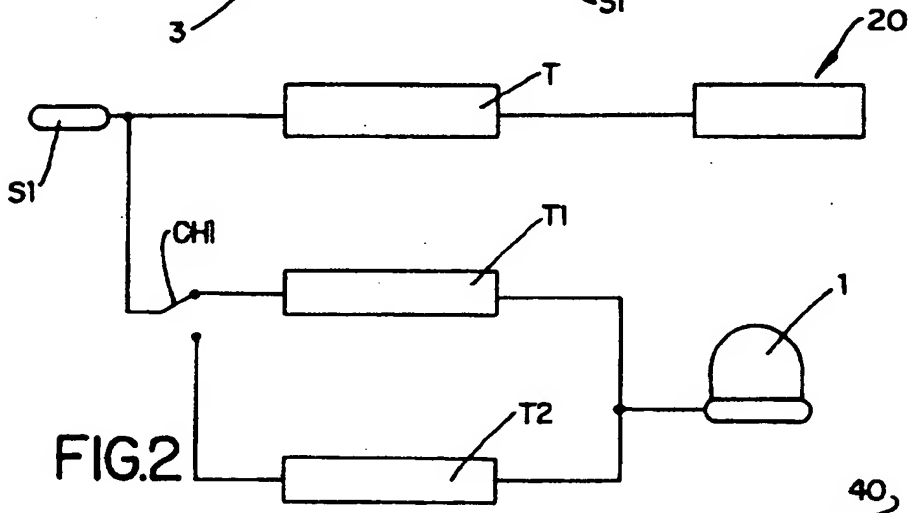

FIG.2

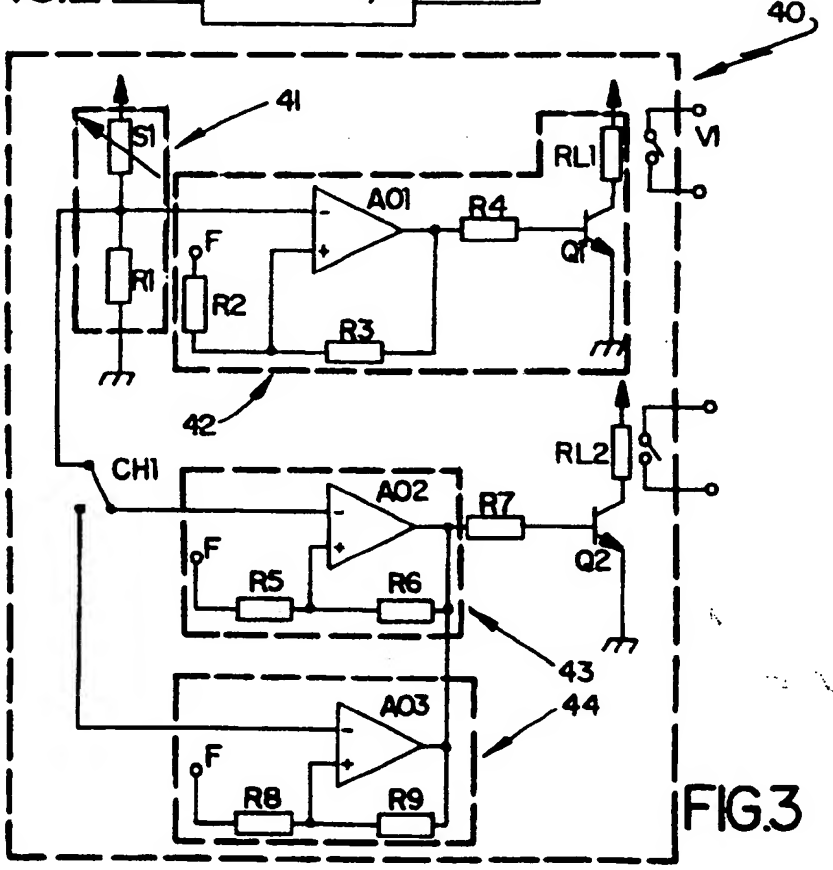

FIG.3

INTERNATIONAL SEARCH REPORT

Int. Application No PCT/BR 95/00065

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F25B41/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F25B

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 008, no. 197 (M-324), 11 September 1984 & JP,A,59 086845 (MATSUSHITA DENKI SANGYO KK), 19 May 1984, see abstract ---	1,3-7
X	PATENT ABSTRACTS OF JAPAN vol. 018, no. 492 (M-1673), 14 September 1994 & JP,A,06 159817 (TOSHIBA CORP), 7 June 1994, see abstract ---	1,3-6
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X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 549 (M-1338), 18 November 1992 & JP,A,04 203757 (HITACHI LTD;OTHERS: 01), 24 July 1992, see abstract ---	1,3-6
A	US,A,5 209 073 (THOMAS DAVID A ET AL) 11 May 1993 see abstract -----	1-6

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